CHARACTERIZATION OF GAS/PARTICLE PARTITIONING AND PARTICLE SIZE DISTRIBUTION OF POLYCYCLIC AROMATIC HYDROCARBONS IN THE ATMOSPHERE IN YUNLIN, TAIWAN

Lee YF*, Duh JM, Duh CC, Chou CP

Energy and Environment Research Laboratories, Industrial Technology Research Institute, Hsinchu, 300 Taiwan,

Abstract

The purposes of this study were including the sampling methodology of polycyclic aromatic hydrocarbons (PAHs) in atmosphere and the characterization on size distribution of PAHs with 16 types in gas and particle phasees in the junior and senior high schools in Yunlin, Taiwan. The sandwich structure of PUF/XAD-2/PUF was exhibited impressive capacity of PAHs in atmosphere followed by the concentrations of PAHs were measured in the range from 28.7 to 89.0 ng/m^3. In addition, the PAHs were accounted for 91.0 to 95.8% in the gas phase as well as 4.2 to 9.0% in the particle phase. Among these samples, two and three rings PAHs associated mainly in gas phase, while the four, five, and six rings PAHs spreaded out in particle phase, respectively..

Introduction

Polycyclic aromatic hydrocarbons (PAHs) are the aromatic family from two to eight rings. There are 100's types of PAHs existing in our environment and 16 of them have been listed as the priority concern by the United States Environmental Protection Agency (USEPA) because they are widespread organic contaminants. On the other hand, Zhang et. al.[1] reported that the total emission of PAHs reached 520 Gg/y by 37 countries in 2004 and the the major souces from China, India, and the United States.

Generally speaking, the distribution of PAHs in gas and particle phases is affected by environmental factors such as temperature, pH, and rainfall. These phenomena may be related with the long range transport and conversional processes. From literatures, the PAHs were mostly in the atmospheric environment in gas phase[2-4]. In terms of seasons, the concentrations of most PAHs were high in winter and low in rainy season[5-7].

Materials and Methods

In this study, samples were carried out at 18 locations (as named from A1 to A18) in the junior and senior high schools in rural areas in Yunlin, Taiwan as illustrated in Fig. 1. The PS-1 sampler of high-flow-rate was specified at 0.225 m^3/min for 48 hours. For collection of PAHs in the atmosphere, the sampling was retained in a quartz fiber filter as well as adsorbents including XAD-2 and PUF. In addition, a surrogate standard was added to the all samples before the samples were collected in order to evalution procedural performance. Next, the PUF, XAD-2, and quartz fiber filter were extracted via the hexane/ether and DCM Soxhlet extraction for at least 18 hours. Sequuemtally, concentated extracts were purificated on a silica gel column. Besides, the internal standard and alternate standard were added during the extraction process and the purification processes to evalute the performance. Finally, the 16 types of organic compounds in PAHs was analyzed by a high-resolution gas chromatography with mass spectrometry (Thermo Trace GC Ultra/DFS).

Results and Discussion

I. Performance evaluation of sampling

In the first stage of the lab analysis, the PUF was selected to use as the adsorbent. The Fluorene-d10 and Terphenyl-d14 were added to all the analyzed samples as the surrogate standards before samples were gathered. Surrogate recovery of the Fluorene-d10 was merely 2% (n=12,SD=1.0%). Therefore, a sandwich structure of PUF/XAD-2/PUF was be appiled to increase the capacity in the second stage. Surprisingly, the mean recovery of Fluorene-d10 was improved to 87% (n=12,SD=12.2%). Note that the recovery of two and three aromatic hydrocarbons were increased significantly such as naphthalene, acenaphthylene, acenaphthene, and fluorene.

In addition, the PAHs were showed the concentration in the range from 37.5 to 89.2 ng/m^3. Comparison with PUF and XAD-2, the XAD-2 prestents more efficiency adsorption rate with 66~83 % than that of PUF.

II. Size distribution of PAHs in gas and particle phases

The concentrations of PAHs were collected from A13~18 locations in Yunlin, Taiwan as shown in Fig. 2. From the Fig. 2, the concentrations of naphthalene and phenanthrene were contributed to 28.7~64.9 ng/m^3 of the total PAHs in Yunlin area. From the literature from Vardar et. al.[2~4], the PAHs were higher in the gas than that of particle phase in the atmosphere. It is agreeed with our results. Besides, the PAHs of two and three-ring were accouted for over 87.9% of the total concentration in gase phase, milewhile, the sum of four, five, and six-ring PAHs were delivered 86.5% of the total concentration in solid phase as displayed in Fig. 2. Figs. 3 and 4 were illustrated that the percentages of 16 types of PAHs were in the gas and paarticle phase, respectively. From Fig. 3, we can see that the naphthalene and phenanthrene were the major PAHs in gas phase. On the other hand, the fluoranthene, pyrene and benzo(b)flrouanthene were contributed PAHs in particle phase.

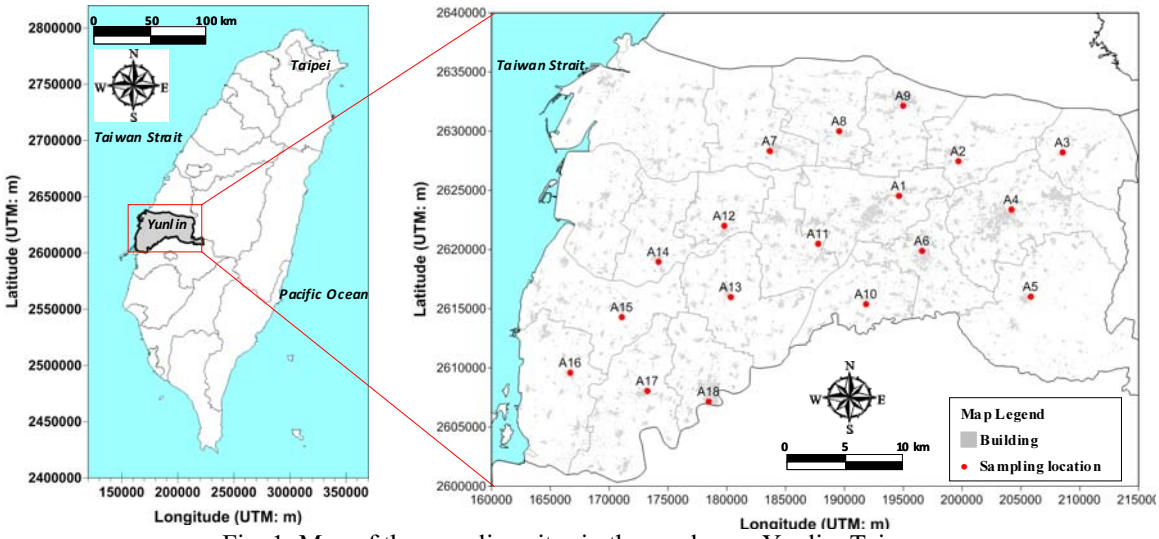

Fig. 1: Map of the sampling sites in the rural area, Yunlin, Taiwan.

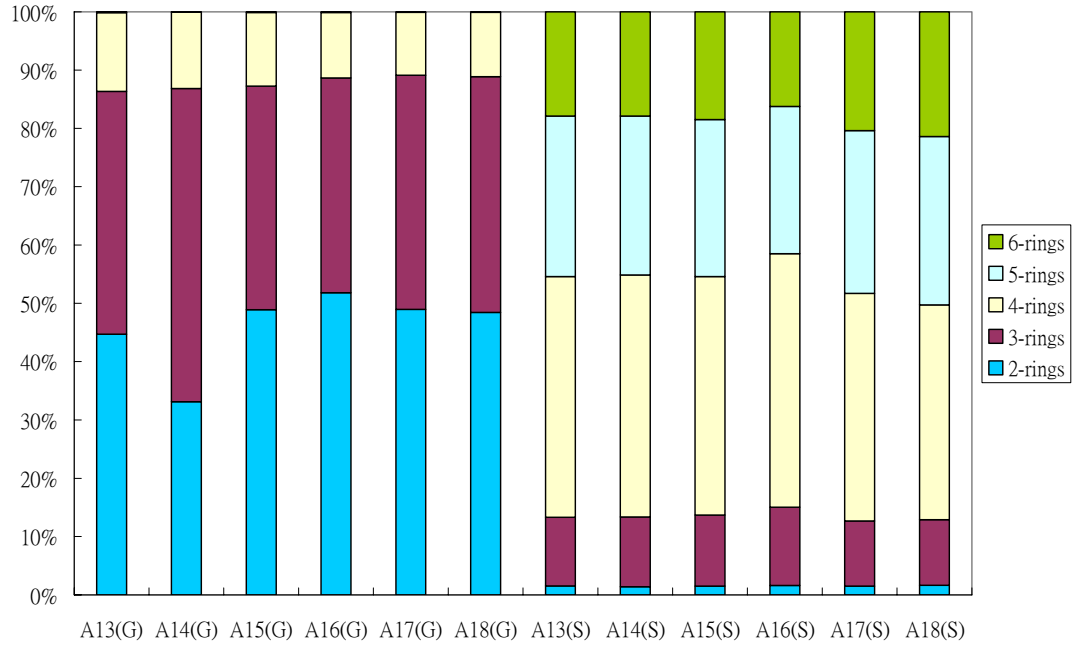

Fig. 2: The distribution of PAHs with two to six rings in gas and particle phase in the atmosphere.

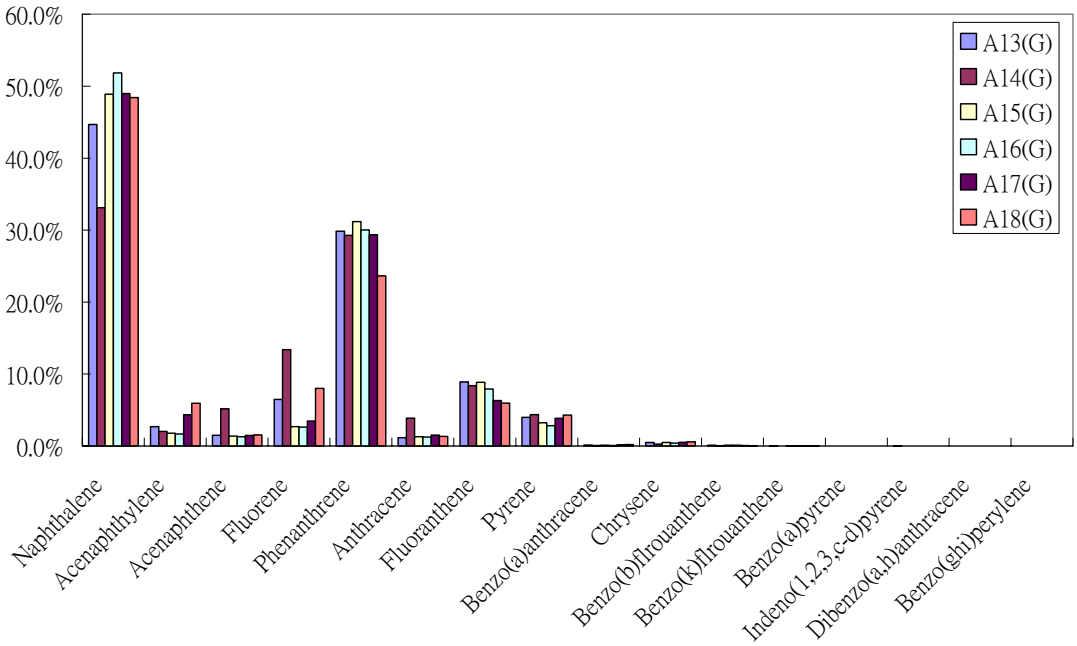

Fig. 3: The percentages of 16 types of PAHs in gas phase.

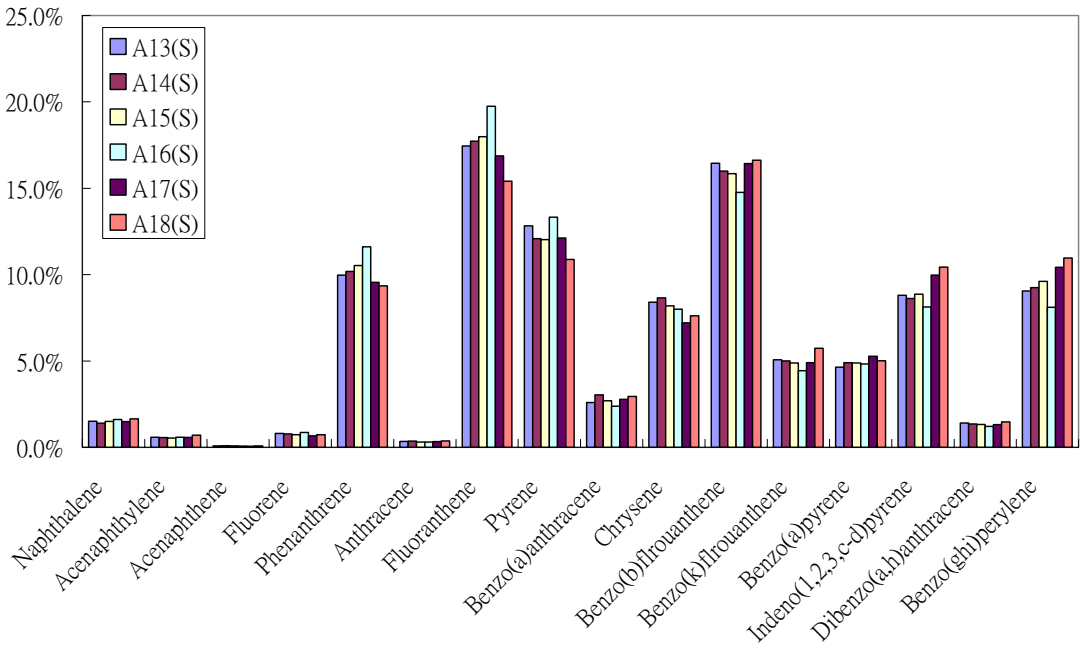

Fig. 4: The percentages of 16 types of PAHs in particle phase.

Reference

1. Zhang Y, Tao S. (2009); *Atmos Environ*. 43: 812-9.
2. Vardar N, Tasdemir Y, Odabasi M, Noll KE. (2004); *Sci Total Environ*. 327: 163-74.
3. Vasilakos C, Levi N, Maggos T, Hatzianestis J, Michopoulos J, Helmis C. (2007); *J Hazard Mater*. 140: 45-51.
4. Fang GC, Chang KF, Lu C, Bai H. (2004);*Chemosphere*. 55: 787-96.
5. Lee SC, Ho KF, Chan LY, Zielinska B, Chow JC. (2001); *Atmos Environment*. 35: 5949-60.
6. Ohura T, Amagai T, Fusaya M, Matsushita H. (2004); *Environ. Sci. Technol*. 38: 49-55.
7. Bozlaker A, Muezzinoglu A, Odabasi M. (2008); *J Hazard Mater*. 153: 1093-102.